(12) UK Patent Application (19) GB (11) 2 134 303 A

(21) Application No 8301776
(22) Date of filing 22 Jan 1983
(43) Application published 8 Aug 1984
(51) INT CL³ G09B 23/00 A63H 3/04
(52) Domestic classification G5G 16 A6S 1F4
(56) Documents cited GB A 2025777 GB 1000273 GB 0730495 GB 0388736 US 4177589
(58) Field of search A6M A6S G5C G5G

(71) Applicant
Thomas J. Greer,
727 23rd Street South,
Arlington,
Virginia 22202,
United States of America.

(72) Inventor
Thomas J. Greer

(74) Agent and/or Address for Service
M. J. Stephens & Co.,
46 Tavistock Place,
Plymouth PL4 8AX.

(54) Facially animated manikin

(57) A facially animated manikin head (100) for simulating human facial expressions includes a rigid substrate (24) in the shape of the head, which is partially covered with elongated, pressurized fluid-filled tubes (10,16) serving as deformable motor elements. The tubes (10,16) are either covered by or embedded in a deformable layer (262) which is positioned on the head to simulate a face, and has its outer surface textured and tinted to simulate facial skin. When various groups of the tubes (10, 16) are deformed by varying the fluid pressure within them, various facial expressions are simulated by the resulting distortion of the contiguous skin layer (262). Alternatively, the deformable motor elements may comprise helical wire coils or a grid of parallel wires embedded in the simulated skin, the passage of a direct current through selected coils or pairs of wires causing them to deform by moving together axially or at right angles to their length respectively, thus distorting the skin layer.

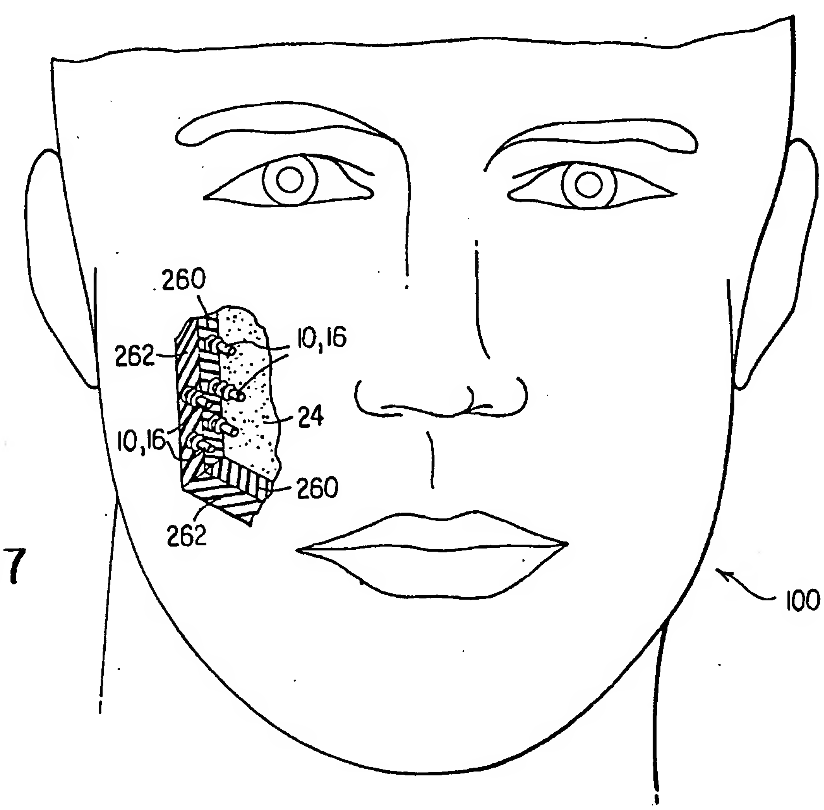


FIG. 7

GB 2 134 303 A

FIG. 1

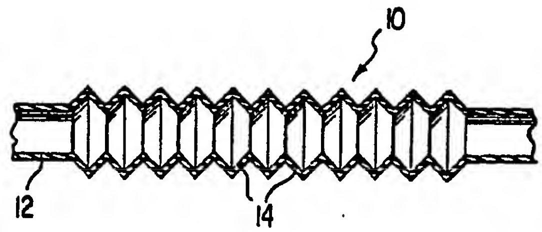


FIG. 2

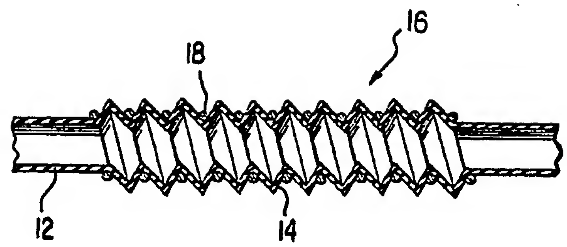


FIG. 3

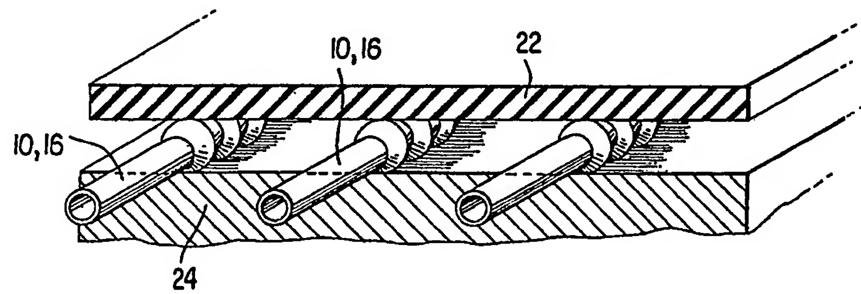


FIG. 3a

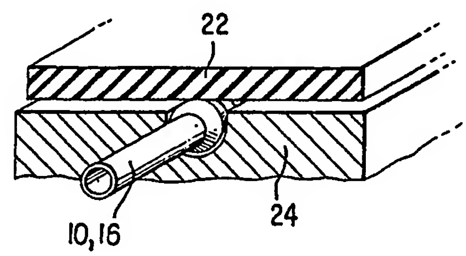
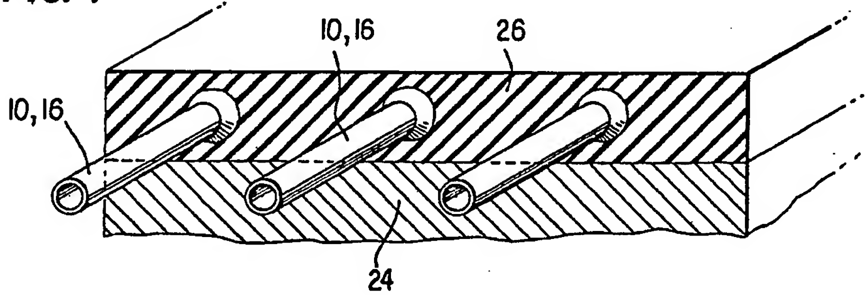


FIG. 4



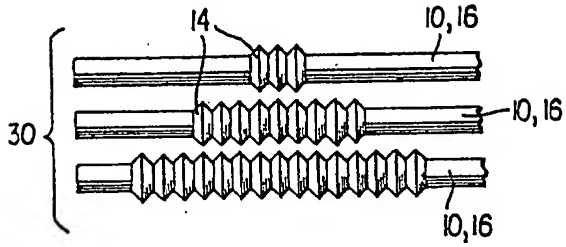
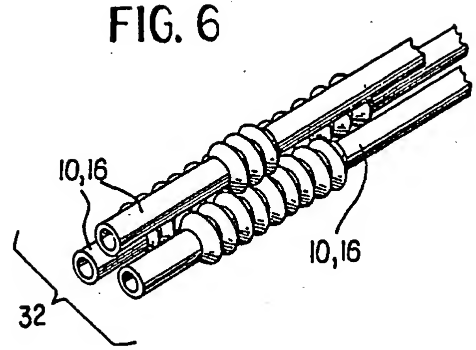


FIG. 5

FIG. 6



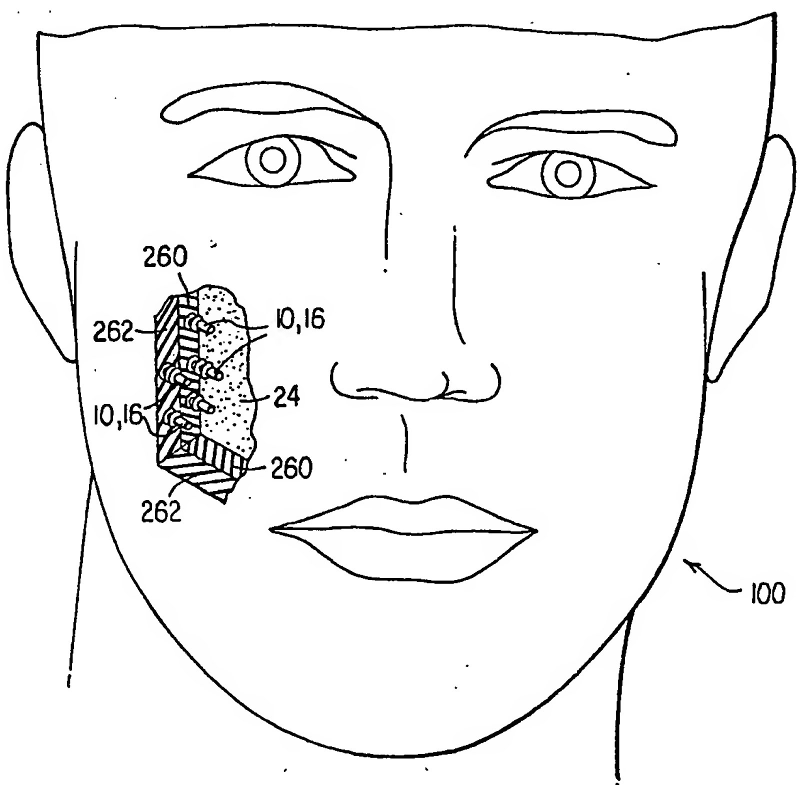


FIG. 7

FIG. 8

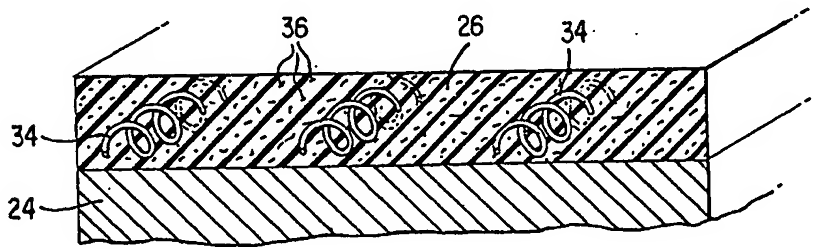
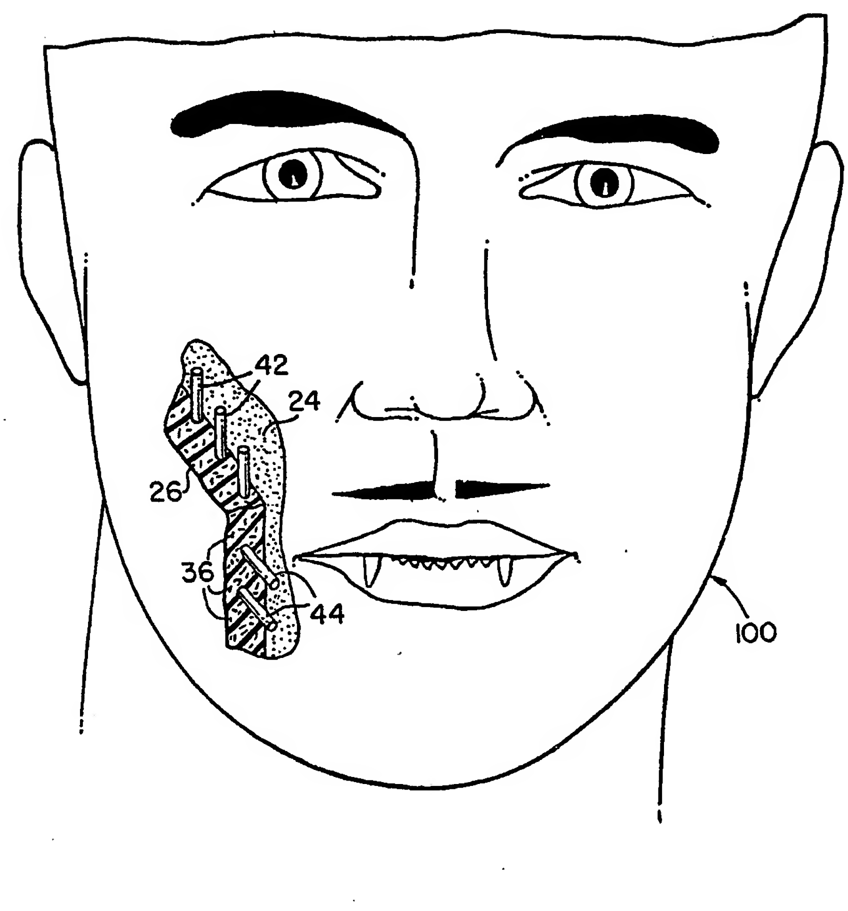


FIG. 9



SPECIFICATION

Facially animated manikin

This invention relates to animated manikins and is more particularly concerned with a facially animated manikin having a facial skin-simulating layer or stratum on its head and motor elements for distorting the skin to simulate facial expressions.

In U.S. Patent 4,177,589 issued to Villa, a motor element for a facially animated manikin is defined by a piston and cylinder wherein the piston is moved by the application of pneumatic pressure within the cylinder, the movement of the piston varying with changes of pressure in the cylinder. The motor element is coupled to and actuates springs around the mouth. While apparently satisfactory for the manikin described in that patent, such motor elements can only imperfectly simulate or imitate actual local distortions or movements of facial skin which take place during human speech and expressions of emotion. In the human face, the facial muscles are elongated, assuming a form similar to narrow, parallel tubular elements.

The object of the present invention is to provide a facially animated manikin with motor elements which permit a more faithful imitation of the facial muscles, and hence expressions in the human face, than is achieved by the prior art.

Accordingly, the present invention provides a facially animated manikin of the type including a substrate in the form of a head, simulated skin placed over at least a portion of the head to form a face, and motor elements intimately associated with the skin for distorting the latter so as to simulate various facial expressions, in which the motor elements comprise deformable members which are in contact with and fixed to the skin so as to be invisible externally thereof, and which are generally parallel to and in conformation with the contour of the skin, whereby the selective deformation of one or more selected motor elements causes distortion and changes in the external appearance of the skin contiguous thereto, thereby simulating facial expressions.

The motor elements disclosed herein are to be distinguished from motors, such as solenoids and the like, for moving the pivoted jaw or rolling the eyes of a manikin.

In one embodiment of the invention, the motor elements are defined by bellows tubes of relatively small diameter, so that, upon the application of varying fluid pressure thereto, the tubes will either elongate or contract. The tubes are connected to a skin-simulating flexible layer or stratum, so that elongation or contraction of the tube motor elements causes surface movement or distortion of the manikin skin.

There are two preferred forms of the bellows motor element, both of which preferably operate from a steady-state or operating point fluid pressure which elongates the motor elements to a steady-state length greater than their unpressurized (such as atmospheric pressure) length. In one form, a deformable tube is provided with expansible bellows having an exterior surface which defines a continuous spiral groove therealong. A resilient spring element, such as a steel spring, is placed within the sprial groove. In the mode of operation of this form of tube, an increase of fluid pressure within the tube above its steady-state or normal value causes the tube and its surrounding spring to elongate beyond its steady-state length by virtue of the expansible bellows. Upon relaxation or reduction of fluid pressure, the resilient coil spring acts to return the tube to its steady-state length. Further reduction in fluid pressure causes the tube to further contract in length (from its steady-state fluid pressure length), due also to the action of the coil spring. A skin-simulating flexible sheet (both elastic and flexible or merely flexible, as later will be explained) is attached to the tube motor elements. Elongation and contraction of the motor elements results in corresponding stretching or bulging of the skin-simulating sheet.

In the second form of tube motor element, the exterior surface of the expansible bellows need not be spiral, although it may be, and each tube motor element is at least partially encased within a substrate or thick sheet of an elastic substrate which defines a simulated human skin on one of its surfaces. Upon an increase in fluid pressure within the tube motor, the tube will lengthen. Upon relaxation of such pressure, the elasticity of the elastic substrate will cause the tube to shorten to its steady-state length. Further reduction in fluid pressure results in further shortening of the tube, due to the elasticity of the substrate. Thus, in the steady-state fluid pressure condition, i.e., the operating pressure value, the elastic substrate is stretched. Alternatively, the resiliency of an elastic, associated skin-simulating sheet may be employed in lieu of a thick stratum.

In both preferred forms of bellows tube, elongation or contraction of the tube motor element will be accompanied by a distortion of the adjacent or contiguous skin-simulating substrate or layer to thereby imitate movements of human facial skin which occur during conversation or emotion. In the first form, the skin layer may be placed on top of the motor elements, with the motor elements being secured to and resting on a hard substrate representing a human skull. In the second form, the elastic substrate which encases the motor elements is attached to and carried by the human skull model.

The tube motor elements may be inherently elastic, rendered elastic by a spring, or deformable only along their length. In the first two cases, the skin-simulating substrate sheet need not be elastic, although it may be. In the third case, the skin-simulating substrate sheet must elastic, so that it will contract upon a reduction in fluid pressure within the tube motor elements.

The tube motor elements of this invention may be employed in a single thickness layer or in the manner of fascia, i.e., a bundle of parallel tubes. The length of the bellows in any given group may be the same or different.

According to a variant of the first embodiment of the invention, two superposed sheets or strata of the

type previously described are placed over the frontal or face portion of the manikin head. The stratum immediately adjacent the head (the first stratum) is used to establish a first facial basis, corresponding to the identity of a first simulated individual. The second or exterior stratum is then employed to produce changing facial expressions for this simulated individual. During the operation of the animated manikin head, the pressures in the tube motors of the first stratum are fixed in time, thereby fixing the identity of the first simulated individual. If it is now desired to simulate or to portray a second individual, the pressures of the tube motors of the first stratum are varied to establish a second facial basis, e.g., higher or lower cheekbones, larger or small jowls, differently shaped forehead, etc. Thereafter, the second or exterior stratum is employed as before to produce changing facial expressions.

According to second and third embodiments of the invention, the elongate, facial muscle-simulating motor elements comprise respectively helical coils and at least partially parallel wires through which a direct current can pass. The adjacent wires and adjacent turns or whorls of the coils, in accordance with well known laws of physics, are attracted towards one another upon passage of the current. The coils and wires are embedded in a deformable skin-simulating layer or stratum. Adjacent wires move towards each other at right angles to their lengths, while adjacent coil turns move towards each other along the longitudinal axis of the coil to contract the latter. In each case, the embedding, skin-simulating stratum is deformed to thereby simulate facial expressions.As described above, two skin-simulating strata may be employed. The force of attraction between adjacent turns or wires may be increased by distributing small ferromagnetic particles, such as soft iron, throughout the embedding stratum or at least in those regions in the neighbourhood of the coils or wires.

In each embodiment, if the difference in facial basis between two simulated individuals is relatively minor, then a single stratum will be sufficient to change the basis. In this case, it is only necessary to vary the steady-state pressures or currents in the motor elements of the single stratum to establish a second set of steady-state pressures or currents about which operation will take place.

The present invention will now be described, by way of example, with reference to the accompanying drawings, in which:

Figure 1 is a partial cross-sectional view of a motor element for a facially animated manikin of a first embodiment;

Figure 2 is a view similar to Figure 2, showing a variant of the motor element;

Figure 3 is a partially-sectioned, diagrammatic perspective view showing one method of fixing the tube motor elements of Figure 1 or Figure 2 to the deformable skin-simulating layer and head substrate of the manikin;

Figure 3a is a view similar to Figure 3, showing a variant thereof;

Figure 4 is a view similar to Figure 3, showing another way of fixing the tube motor elements to a skin simulating layer;

Figure 5 is a plan view showing a group of three motor elements of the type shown in Figure 1 or Figure 2 lying in a plane;

Figure 6 is a perspective view showing three motor elements of the type shown in Figure 1 or Figure 2 arranged non-coplanarly and in the form of fascia;

Figure 7 is a cut-away perspective view showing the head of a facially animated manikin according to a variant of the first embodiment, having two layers or strata of deformable material associated with motor elements of the type shown in Figure 1 or Figure 2;

Figure 8 is a view similar to Figure 4, showing motor elements for a facially animated manikin according to a second embodiment of the invention, and

Figure 9 is a view similar to Figure 7, showing the head of a facially animated manikin according to a third embodiment of the invention.

Referring now to Figure 1 of the drawings, the numeral 10 denotes a tube motor element for use in a first embodiment of this invention. The element is in the form of tube 12 formed of elastomer or other deformable material. The tube is provided with a plurality of bellows sections denoted generally by the numeral 14. Alternatively, the tube and the bellows may be formed of thin metal. Depending upon how the tube 10 is used (later to be described), it may be deformable and elastic, or may be merely deformable without the property of elasticity. The bellows elements may be normal to the longitudinal axis of the tube 10, or they may form a spiral. It will be seen that, with the tube ends closed to thereby define a closed volume, an increase in fluid pressure in the interior will result in an elongation of bellows portion of the tube. Any change in the diameter of the smooth portion or of the bellows portion will be negligible.

Referring now to Figure 2, the numeral 16 denotes a second form of the tubular fluid motor of this invention, again defined by a tube 12 of generally thin walls. The expansible bellows portion 14 is of the same general construction as that shown in Figure 1, but here it is in the form of a spiral. The spiral groove defined is provided with a spring element 18, such as a steel coil spring. In operation, an increase in fluid pressure within the interior of tube 12 will, again, result in elongation of the tube by expansion of the bellows 14. Upon relaxation of fluid pressure, the spring 18, due to its natural resiliency, will urge the tube 12 to return to its original or steady-state length.

Referring now to Figure 3 of the drawings, the numeral 24 denotes an external facial portion of simulated human skull or other manikin head formed of plastics, wood, hard resinous material, or the like. The numeral 22 denotes a facial skin-simulating material defining a deformable layer of elastomer such as, for example, of methylpolysiloxane, natural rubber or synthetic rubber such as ethylene/propylene copolymers, SBR (butadiene/styrene copolymer), polyisobutylene, polybutadiene, nitrile rubbers (butadiene/acrylonitrile copoly-

mers) and the like. These elastomers, which are characterized by the property of substantial elasticity or resiliency as well as the ability to be deformed or distorted without substantial stretching, are well known (U.S. Patents 2,492,129 to Spring; 2,457,688 to Krieble; 3,454,676 to Busse; 3,467,620 to Orr, and 3,836,511 to O'Farrell). Alternatively, the facial skin-simulating material 22 may be comprised of a substance which is merely of deformable nature, i.e., one which is deformable, but which exhibits little, if any, resiliency or elasticity. Such materials are well known and include, for example, polyvinyl chloride, polyethylene, polypropylene, polyamides; such as Nylon 6,6, and polyesters, such as polyethylene terephthalate. Layer 22 and substrate 24 sandwich a plurality of tube motor elements, denoted generally by the numerals 10, 16 to show that the motor element of either Figure 1 or of Figure 2 may be used. If the sheet 22 is elastic, either motor elements 10 or motor elements 16 may be employed. It is necessary that either the skin-simulating sheet member 22 or the motor element must provide resiliency to thereby return to a normal or steady-state position upon decrease of fluid pressure within the motor elements. If non-elastic motor elements 10 are chosen, then sheet 22 must be elastic. If the motor elements 10 are elastic, then the sheet 22 need only be deformable. If motor elements 16 are chosen, then sheet or layer 22 need only be deformable, although it may also be elastic. From a consideration of Figure 3, the reader will observe that distortion of the skin-simulating layer 22 to simulate facial expressions may be achieved by a change in the fluid pressure in pre-selected sub-groups of the tubular motor elements. A steady-state pressure, preferably above atmospheric, within the motor elements 10, 16 is such that the motor elements are normally lengthened in their steady-state condition, i.e., a fixed facial expression of the manikin. Variations of the pressure about this steady-state value will result in either a contraction and consequent bulging of layer 22 immediately contiguous to the particular sub-group of motor elements involved, or will result in a corresponding stretching of layer 22. Thus, in the embodiment of Figure 3, to simulate a facial expression or an emotion on a manikin head according to this invention, it is necessary to selectively vary the pressure within certain ones of the tubular motor elements 10, 16 about their steady-state value to thereby produce either a bulge or a stretching in the contiguous skin-simulating layer 22.

The tube motor elements 10, 16 of Figure 3 may also be placed in complementary grooves on the surface 24 of the manikin head, as shown at Figure 3a. The midportion of a given tube motor for both Figures 3 and 3a is fixed to the substrate 24, as by adhesive, while the top portions of each or selected ones of the bellows elements 14 are attached, as by adhesive, to the lower surface of sheet 22.

The manner of correlating speech (lip movements, frowns, smiles, etc.) from an electrical or other speaker in the manikin head 24 with pressure variations of specific sub-groups of motor elements 10, 16 to produce time varying correspondence between movements of portions of facial skin-simulating sheet 22 does not form a part of this invention. Such correlation may be established by routine experimentation. The amount of deviation from steady-state pressure is varied to produce a desired expression, by an amount dependent on the material of the simulated skin as well as the number and positioning of the motor elements.

Referring now to Figure 4 of the drawings, another construction is shown, which may also employ either tube motor elements 10 or 16. In Figure 4, the motor elements are completely embedded or encased within a relatively thick deformable layer or stratum 26, comprised of a deformable plastics or an elastomer as defined above in connection with sheet 22. Again, as with sheet 22, the outer surface of the layer is textured and coloured to simulate human skin. As in the embodiment of Figure 3, if the substrate 26 is merely deformable and not elastic, then elastic tube motor elements such as 16 must be employed. On the other hand, if the stratum 26 is elastic as well as deformable, then either a non-elastic motor element or the motor element 16 may be employed. The operation is similar to that described with respect to Figure 3. The individual bellows sections of 14 are attached, as by adhesive, at their outer rims to the interior of circular passages running within stratum 26. Alternatively, the stratum 26 may be molded around the tube motors.

If the tube motor elements of either Figure 3 or Figure 4 are not elastic, then either the elastic skin (Figure 3) or the elastic layer (Figure 4) must be placed in association with the tubes when the tubes are pressurized to their steady-state pressure condition.

Referring now to Figure 5 of the drawings, an arrangement of the tube motor elements into sub-groups 30 is illustrated. In general, the motor elements (tubes 10, 16) are parallel and substantially co-planar to or at least follow, the contour of the manikin head substrate 24. While illustrated as being three in number, the reader will understand that any convenient number may define a sub-group 30. The length of the bellows elements on different ones of the several tube motors 10, 16, forming sub-groups 30 is varied, so that for any one sub-group, a selected one or ones of the motor elements may be actuated (their pressures either increased or decreased) to produce different maximum motor stroke lengths of that particular sub-group. The sub-groups 30 may be used with the construction of Figure 3 or Figure 4.

Referring now to Figure 6, the numeral 32 denotes a sub-group similar to sub-group 30 except here the tube motor elements 10, 16 are in a fasces or bundle, each member of the sub-group having a bellows portion of a different length. Again, selected ones of any sub-group 32 lying over the substrate 24 may be actuated by variation of fluid pressure therein. The reader will observe, from a consideration of Figures 5 and 6 and a comparison with Figures 3 and 4, that any of the sub-groups 30, 32 may be visualized as taking the place of any of the illustrated single motor elements. The choice of whether to employ generally flattened sub-groups 30, relatively thick sub-groups 32 or single elements, such as shown at

Figures 3 and 4, will depend upon the length of the individual motor elements and upon the types of expressions which are contemplated for the manikin, as well as the size of the manikin head. It will also depend upon the motor element location on the manikin face. For example, the lip muscle *orbicircularis oris* may be simulated by bundle groups 32, while the nose muscle *dilatator naris anterior* may be simulated by flat groups 30.

Motor elements of the general type of this invention are themselves already known. For example, U.S. Patent 1,561,065 of 1924, issued to Eggleston, discloses an expansible and collapsible element which includes a bellows construction with a spring. Further, U.S. Patent 1,744,241 of 1930, issued to Pierle, shows a deformable tube having a spiral corrugation, the corrugation being provided with a coil spring. Further, U.S. Patent 4,241,740 of 1980, issued to Brown, shows a contractable element of the same general type. However, none of these prior art constructions discloses the use of such a tubular element as a motor element for simulation or imitation of the muscles of the face, being in combination with a skin-simulating layer or sheet and a manikin head.

Further, the use of bellows in animated human figures is already known. In U.S. Patent 2,047,377, issued in 1936 to Liwschutz, as well as the same inventor's U.S. Patent 2,065,473 issued in 1936, bellows are employed at the joints of articulated limbs for the purpose of moving the limbs. Pressure variations within the bellows cause their contraction/expansion with consequen limb motion. Liwschutz also contemplates such bellows for moving parts of the face of the figure, such as the lower jaw, the lips and the eyes. Additionally, Liwschutz employs a talking machine connected to the figure. While superficially similar to the present invention in the sense that both employ bellows, the bellows of Liwschutz is merely one type of fluid motor for effecting limb, jaws, eye, etc. movements of an animated figure. They are not used in any way to simulate by distortion any wrinkling, stretching, bulging or the like of facial skin on an animated manikin.

In use, it will be apparent that each tube motor element interior forms part of a closed fluid volume, preferably of air. Pneumatic valves may be employed to modulate the air pressure within the various tube motors about their steady-state value. While shown as disposed parallel to each other, it will be apparent that the tube motors may be placed at angles to one another in different planes or layers.

The invention thus far described relates to the simulation of skin movements such as wrinkling, stretching, etc., on simulated skin for an animated figure or manikin. Thus, with a head substrate 24 resembling a first individual, the practice of this invention will enable the simulation of a variety of facial expressions, usually those taken in connection with and corresponding to a voice of the figure. If it is desired to portray a second human, having different facial characteristics, then ordinarily a second head substrate 24 having a different facial basis or shape would be employed. However, according to a variant of the first embodiment, the use of a second or other deformable substrate such as 26 to portray other faces having different facial characteristics is not always necessary.

According to this variant of the first embodiment, primary layer of stratum of elastomer or deformable material such as 26 with its associated tube motors 10, 16 is first placed over and mounted on the surface of the head substrate 24. Assuming that the entire face of the manikin head 24 is covered with the primary layer, it will be immediately apparent that by suitable establishment of pressures within the various tube motors, desired facial basic characteristics such as thickness of lips, distance between eye sockets, height of cheekbones, etc. may be established. Once these various tube pressures are established, they are not varied, such time-fixed pressures in the tube motors establishing a simulation of a first human. Beforehand, a secondary sheet or layer of elastomer or deformable material (again such as 26) is placed over the primary layer or sheet. The second layer, as well as the primary layer, may be constructed in the manner already described. Thus, during operation of the animated manikin representing a given first individual, the secondary or outer layer or sheet is operated in the manner previously described.

It will, of course, be immediately apparent that the secondary sheet or layer may be applied to the primary sheet prior to the establishment of the basic facial proportions established by a first set of steady-state pressures within the tube motors of the primary layer or stratum.

In the event that it is now desired, at a different point in time, to portray or to represent a second individual, then it is only necessary to establish a set of pressures within the tube elements of the primary layer and thereby define the basic facial proportions, etc., of the second human to be portrayed, and thereafter operate the secondary layer as before. Obviously, a great number of basic facial proportions may be defined by fixing a set of steady-state pressures within the tube motors of the primary layer. Thus, by this variant of the first embodiment, the manikin head is provided with a primary layer for establishing the basic facial proportions of an individual to be portrayed, while the secondary layer simulates emotions and other facial movements which might accompany speech, for example, of the individual simulated. Thus, at different times, merely by changing facial makeup of an animated manikin constructed in accordance with this invention, it is possible to portray a great number of individuals.

The use of a primary and secondary layer or stratum is illustrated at Figure 7 as employed with a manikin head 100. A primary layer 260 is placed over the manikin head. This stratum is of the same construction as stratum 26 shown at Figure 4. Alternatively, it may be of the construction shown at Figures 3 or 3a. A secondary or outer stratum 262, of similar construction to 260, is superposed over stratum 260. The two strata may touch, as shown, or they may be separated by a deformable wall. Their operation is as follows.

The gross or major facial proportions of the

individual to be simulated are fixed by actuation of the tube motors 10, 12 of primary stratum 260, the latter corresponding to layer 26 of Figure 4. This may be done by routine experimentation, until the desired facial proportions are achieved. Thereafter, the fluid pressures in the various tube motors of the primary stratum are held constant in time.

The second stratum 262 is now operated as previously described with respect to Figures 1 to 6, i.e., as though the stratum 262 had been placed over a manikin head having fixed, unchanging facial proportions.

If it is now desired to simulate an individual having different facial proportions, the pressures in tube motors 10, 12 of primary stratum 260 are varied to obtain (again by routine experimentation) the desired proportions.

To facilitate an understanding of the invention, the tube motors 10, 16 have been shown as mutually parallel. In practice, it is preferable to arrange them in the manner of the actual facial muscles, as shown, by way of example, at Figure 195 on page 299 of Gray's Anatomy, published by Bounty Books, New York, copyright 1977.

Referring now to Figure 8 of the drawings, a second embodiment of the invention is shown partially, also in combination with a skin-simulating layer or stratum. The numeral 26 denotes, as before, a stratum of an elastomer material, the stratum being placed on a portion of the surface 24 of a manikin. Numeral 30 denotes any one of plurality of elongated spring elements in the form of coil springs. For clarity in presentation, only two coil springs are shown and the ends of these coil springs are illustrated as extending beyond an edge or section of the elastomer 26. The coils 30 are formed of an electrically conductive material, such as copper, and are embedded within the elastomer 26. The numeral 32 denotes small particles of ferromagnetic material such as soft iron.

The mode of operation of the embodiment of Figure 8 will now be described. By means of suitable connections, not illustrated, electrical currents are passed through each of the individual coil spring elements 30. These springs may be relatively weak, since elasticity may be derived from the elastomer 26. The relative elasticity or resiliency between the elastomer 26 and the spring 30 may be varied for different applications. For greater spring elasticity, steel springs may be used. It is known that when an electrical current passes through two parallel wires, the current passing in the same direction in each wire, then the wires will undergo a force tending to move them towards one another. Because of this well known physical effect, the reader will now readily comprehend that adjacent turns or whorls of each of coil spring elements 30 will undergo a force tending to move them all together upon a passage of an electrical current through the coils. In order to enhance or make stronger this well known electromagnet effect, ferromagnetic particles 32 are added to the elastomer 26 so as to increase the strength of the magnetic field which arises by passage of current through coils 30. The art of combining ferromagnetic particles in flexible materials is known (U.S. Patents 4,110,236 to Molina, 3,764,539 to Cochardt, 2,719,009, and 3,428,603 to Kroenke). It will now be apparent that upon passage of sufficient current through the coils they will contract in length and thereby deform the layer or stratum 26 in which they are embedded. The normal or steady-state current value in the coils may be such that there is slight shortening of the coils in this steady state, while an increase of current will cause further shortening and further consequent pinching of the elastomer 26. A lessening of the current will then result in relative stretching of the coils 30 with a consequent smoothing out or tensioning of the elastomer 26 in those regions immediately adjacent to the coils. Preferably, the coils 30 are placed relatively close to the exposed surface of skin-simulating stratum 26.

The reader will now be in the position to comprehend that coil springs 30 may be employed in a manner completely analogous to tube motor elements 10, 16 of the embodiment of Figures 1 to 6. Accordingly, it will be clear that coil springs 30 may be employed not only as illustrated in Figure 6 (corresponding to Figure 4), but also in the manner illustrated corresponding to Figures 3, 5 and 6. It will also be apparent that the embodiment of Figure 8 may be employed in the manner shown and described in respect to Figure 7.

Instead of helical coil spring motor elements, flexible wires, which may also be embedded in a ferromagnetic particle containing elastomer, may be employed. The wires are formed to assume the outline and contours of the manikin face, the wires being parallel over at least partial segments thereof, as in the manner of a bird cage or a fencing mask. Passage of direct current through selected pairs and groups of pairs, determined by routine experimentation, will also result in simulation of facial expressions. For more faithful simulation, two grids of wires, at right angles to each other may be employed. This is illustrated at Figure 9 wherein a first grid of generally parallel wires 42 is embedded in elastomer stratum 26 having ferromagnetic particles 36 dispersed therein. A second grid of wires 44 is oriented at right angles to the wires of the first grid. By means of suitable connections, not illustrated, each of the wires of the first and second grids may pass currents along their entire length or only along selected portions thereof. As in the embodiment of Figure 8, the magnetic fields between adjacent, parallel wires cause them to move together, thus deforming the contiguous elastomer stratum.

CLAIMS

1. A facially animated manikin of the type including a substrate in the form of a head, simulated skin placed over at least a portion of the head to form a face, and motor elements intimately associated with the skin for distorting the latter so as to simulate various facial expressions, in which the motor elements comprise deformable members which are in contact with and fixed to the skin so as to be invisible externally thereof, and which are generally parallel to and in conformation with the contour of

the skin, whereby the selective deformation of one or more selected motor elements causes distortion and changes in the external appearance of the skin contiguous thereto, thereby simulating facial expressions.

2. A facially animated manikin of the type including a substrate in the form of a head of a real or an imaginary individual, the substrate being provided with motor elements for distorting simulated skin positioned over at least a portion of the head substrate, such skin distortions simulating various facial expressions of the individual's face associated with the head, wherein the motor elements are defined by expansible and contractable tubes which are expansible and contractable along their lengths upon variation of fluid pressure therein, the tubes being in contact with and fixed to the skin so as to be invisible at the exterior surface of the skin, and being generally parallel to and following the contour of the skin, whereby the selective variation of the pressure within certain of the tubes causes changes in the external appearance of the skin contiguous thereto due to distortion of the skin by the tubes, thereby simulating facial expressions, the skin and tube motor elements defining a first layer or stratum.

3. A manikin according to Claim 2, wherein the tubes are elastic and are able to contract to a normal or rest length upon relaxation of the fluid pressure therein.

4. A manikin according to Claim 2, wherein the skin is elastic and has a normal or rest configuration, so that an increase of fluid pressure within the tubes causes the skin contiguous to the tubes having the increased fluid pressure to stretch parallel to the direction of tube elongation, and whereby relaxation of the fluid pressure within the tubes results in the skin returning to its normal configuration.

5. A manikin according to Claim 3 or Claim 4, wherein the skin is in the form of a sheet, and wherein the tubes are positioned between the head substrate and the skin sheet.

6. A manikin according to Claim 4, wherein the skin is in the form of a layer whose thickness is greater than the diameter of the tubes, and wherein the tubes are at least partially embedded in said layer.

7. A manikin according to Claim 6, wherein the tubes are completely embedded in said layer.

8. A manikin according to Claim 2, wherein the manikin is provided with a second layer or stratum similar to the first layer or stratum, whereby the first layer or stratum is employed to establish a first set of basic facial proportions corresponding to a first simulated individual and the second layer or stratum is employed to simulate facial expressions thereof, such as those occurring during conversation, and whereby the first layer or stratum may subsequently be employed to establish a second set of basic facial proportions corresponding to a second simulated individual, the facial expressions of which are simulated by the second layer of stratum.

9. A manikin according to any one of Claims 2,3,4,6,7, or 8, wherein the tube motor elements are defined by bellows.

10. A manikin according to Claim 9, wherein the fluid within the tubes is a gas.

11. A facially animated manikin of the type including a substrate in the form of the head of an individual, the substrate being provided with motor elements for distorting simulated skin positioned over at least a portion of the head substrate, such skin distortions simulating various facial expressions of the individual's face, wherein the motor elements are defined by helical coils each formed from an electrically conductive wire, whereby the passage of a direct current through each helical coil gives rise to a force of attraction between adjacent turns of the helical coil to thereby cause the helical coil to contract along its length, the coils being in contact with and fixed to the skin so as to be invisible at the exterior surface of the skin, and being generally parallel to and following the contour of the skin, so that, upon application of direct current to the coils, changes in the external appearance of portions of the skin contiguous to the coils, due to distortion of the skin by the coils, are effected to thereby simulate facial expressions, the skin and coil motor elements defining a first layer or stratum.

12. A manikin according to Claim 11, wherein the coils are embedded in the simulated skin.

13. A manikin according to Claim 11, wherein each helical coil is elastic along its length, so that each helical coil will return to a normal length when no current passes through it.

14. A manikin according to Claim 12, wherein the simulated skin is elastic.

15. A facially animated manikin of the type including a substrate in the form of the head of an individual, the substrate being provided with motor elements for distorting simulated skin positioned over at least a portion of the head substrate, such skin distortions simulating various facial expressions of the individual's face, wherein the motor elements are defined by conductive flexible wires, each wire being parallel to an adjacent wire over at least segments of its length, the assembly of said wires following the outline and contour of the face of the manikin, and the wires being embedded in an elastomer stratum which defines said simulated skin, whereby the passage of a direct current through selected pairs of the wires gives rise to a force of attraction between adjacent parallel segments of the selected pairs to thereby cause the parallel segments to move towards each other at right angles to their length, thereby causing changes in the external appearance of portions of the skin contiguous to the pairs of parallel segments, due to distortion of the skin, to thereby simulate facial expressions.

16. A manikin according to any of Claims 11, 12, 13, 14 or 15, wherein ferromagnetic particles are dispersed in the simulated skin to increase the effective magnetic permeability of the simulated skin and thereby increase the force of attraction between adjacent coil turns or wire segments when a current is passed therethrough.

17. A facially animated manikin substantially as herein described with reference to, and as shown in, Figures 1 to 7, Figure 8 or Figure 9 of the accompanying drawings.

Superseded claims ALL
New or amended claims:-

1. A facially animated manikin including a substrate in the form of a head, simulated skin placed over at least a portion of the head to form a face, and independently actuable motor elements intimately associated with the skin for distorting the latter so as to simulate various facial expressions, the motor elements comprising deformable members which are in contact with and fixed to the skin so as to be invisible externally thereof, and which are generally parallel to and in conformation with the contour of the skin, the motor elements deforming upon actuation in directions substantially parallel to and in conformation with the contour of the skin, whereby the selective actuation of one or more selected motor elements causes distortion and changes in the external appearance of the skin contiguous thereto, thereby simulating facial expressions.

2. A manikin according to Claim 1, wherein the motor elements are defined by expansible and contractable tubes which are expansible and contractable along their lengths, with a negligible change in their diameters, upon variations of fluid pressure therein.

3. A manikin according to Claim 2, wherein the tubes are elastic and are able to contract to a normal or rest length upon relaxation of fluid pressure therein.

4. A manikin according to Claim 2, wherein the skin is elastic and has a normal or rest configuration, so that an increase of fluid pressure within any tube causes the skin contiguous to the tube to stretch parallel to the direction of tube elongation and whereby a relaxation of fluid pressure within the tube results in the skin returning to its normal configuration.

5. A manikin according to Claim 3 or Claim 4, wherein each tube operates from a steady-state pressure at which it is slightly expanded and the skin contiguous thereto is in a normal configuration, whereby pressure increases and reductions in the tube cause respective expansions and contractions thereof and corresponding stretching and compression or bulging of the contiguous skin.

6. A manikin according to Claim 3, Claim 4 or Claim 5, wherein the skin is in the form of a sheet and the tubes are positioned between the head substrate and the skin.

7. A manikin according to Claim 3, Claim 4 or Claim 5, wherein the skin is in the form of a layer whose thickness is greater than the diameter of the tubes, and wherein the tubes are at least partially embedded in said layer.

8. A manikin according to Claim 7, wherein the tubes are completely embedded in said layer.

9. A manikin according to any one of Claims 2 to 8, wherein the tube motor elements are constituted by bellows tubes.

10. A manikin according to Claim 9, wherein each bellows tube defines a spiral groove and a coil spring is positioned externally in this groove.

11. A manikin according to any one of Claims 2 to 10, wherein the tube motor elements are arranged in groups or fascia to simulate human facial muscles.

12. A manikin according to Claim 1, wherein the motor elements are defined by helical coils formed from electrically conductive wire, whereby the passage of a direct current through each helical coil gives rise to a force of attraction between adjacent turns of the coil to thereby cause the coil to contract along its length and distort the skin contiguous thereto.

13. A manikin according to Claim 12, wherein the coils are embedded in the skin.

14. A manikin according to Claim 12 or Claim 13, wherein the skin and the coils are elastic and the current passing through the coils has a normal or steady-state value at which the coils exhibit a slight degree of contraction and the skin contiguous thereto is in a normal configuration, whereby increases and decreases in the current from the normal value causes respectively further contractions and relaxations of the coils and corresponding compression and stretching of the skin.

15. A manikin according to Claim 1, wherein the motor elements are defined by conductive flexible wires which are embedded in elastic skin and follow the contours of the face of the manikin, each wire being parallel to an adjacent wire over at least segments of its length, whereby the passage of a direct current through selected pairs of wires gives rise to a force of attraction between adjacent parallel segments of the selected pairs to thereby cause the parallel segments to move towards each other at right angles to their length and distort the skin contiguous thereto.

16. A manikin according to Claim 15, wherein the wires form two grids of generally parallel wires at right angles to each other.

17. A manikin according to Claim 12 or Claim 15, wherein ferromagnetic particles are dispersed in the skin to increase the effective magnetic permeability of the skin and thereby increase the force of attraction upon the passage of current through the coils or wires.

18. A manikin according to any of the precedng claims, wherein the skin and its associated motor elements define a first layer or stratum and a second layer or stratum also defined by skin and associated motor elements is provided externally of the first, whereby the first layer or stratum is employed to establish a first set of basic facial proportions corresponding to a first simulated individual and the second layer or stratum is employed to simulate facial expressions thereof, and whereby the first layer or stratum may subsequently be employed to establish a second set of basic facial proportions corresponding to a second simulated individual, the facial expressions of which are again simulated by the second layer or stratum.

19. A facially animated manikin substantially as herein described with reference to, and as shown in, Figures 1 to 7, Figure 8 or Figure 9 of the accompanying drawings.

Printed for Her Majesty's Stationery Office, by Croydon Printing Company Limited, Croydon, Surrey, 1984.
Published by The Patent Office, 25 Southampton Buildings, London, WC2A 1AY, from which copies may be obtained.